THE EFFECT OF A UNIFORM MAGNETIC FIELD ON ELECTRODELESS DISCHARGE IN A TUBE AND MEASUREMENT OF ELECTRONIC MOBILITY II. OXYGEN, NITROGEN, CARBONDIOXIDE AND HYDROGEN.

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ABSTRACT. Results of measurements of the percentage increase in the breakdown potential and of electronic mobility in a discharge tube filled with O_2, N_2, CO_2 and H_2, and excited with a 50-cycles alternating voltage, under a uniform magnetic field have been reported. Measurements are made at different pressures and under magnetic fields inclined at different angles with the electric field.

INTRODUCTION

In a previous communication the author (Goswami, 1958) reported that the value of the breakdown potential in dry air in an electrodeless discharge tube, excited with a 50-cycles alternating voltage, is increased in a magnetic field. The percentage increase in the breakdown potential is dependent upon the pressure, the strength of the magnetic field and its inclination with the electric field. The main features of the observed phenomena were satisfactorily explained in the light of the theory presented by Deb and Goswami (1956). In the present investigation, results of similar measurements in oxygen, nitrogen, carbondioxide and hydrogen are reported and compared with those in dry air.

EXPERIMENTAL

The experimental arrangement was practically identical with the one described in our previous communication, except that particular attention was given to make the discharge system free from moisture, grease-vapour etc.

RESULTS AND DISCUSSION

The results of measurement are given in Tables I-IV from which the variations of the percentage effect and the electronic mobility with pressure for different values of the magnetic field at different inclinations can be obtained. The variations, with pressure, of the percentage effect are also graphically represented for only two values of the magnetic field for each of the gases in figures 1—8 and of the electronic mobility in figures 9—12.

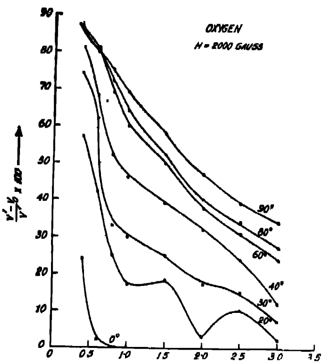

Fig. 1.

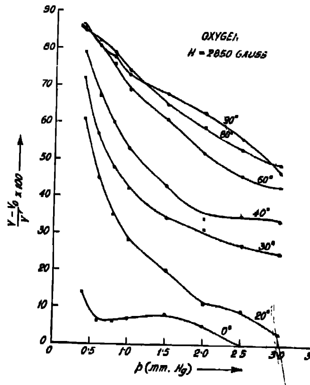

Fig. 2.

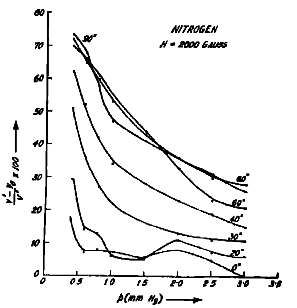

Fig. 3.

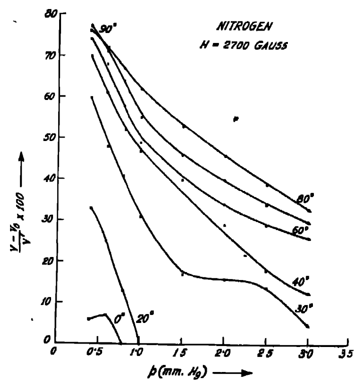

Fig. 4.

A comparison of the results with those for dry air reported previously (Goswami, 1958) shows that the variations in both cases are similar. Table I-IV.

It may be seen that the curves representing the variation of $\frac{V'-V_0}{V'}$ with pressure as also of the electronic mobility with pressure have trends more or less similar to rectangular hyperbolas. It is interesting to note that this result is in agreement with the theory.

TABLE I

Values of $\frac{V'-V_0}{V'}$ and μ_e for oxygen

	$\frac{V'-V_0}{V'}$												$\mu_e \times 10^{-5}$ ($\theta = 90°$) cm²/volt. sec.		
	$\theta = 0°$			30°			60°			90°					
p-mm Hg \ H in gauss	1525	1750	3325	1525	1750	3325	1525	1750	3325	1525	1750	3325	1525	1750	3325
0.4	.00	.17	.15	.61	.61	.76	76	78	80	.75	81	85	.86	.79	.43
0.6	.00	.12	.06	.48	.41	64	.70	.67	.74	70	.73	.80	.83	.74	.41
0.8	.00	.14	.00	.36	.35	52	63	.54	.65	.56	.65	77	.73	.69	.40
1.0	.00	.12	.00	.24	.36	.46	.52	.46	.57	.44	.58	.72	.64	.65	.39
1.5	.00	.15	.00	.13	.31	31	.40	.40	.50	.34	.50	.66	.56	.60	.37
2.0	.00	.12	.00	.14	.27	.26	.28	34	.46	.32	.42	.59	.54	.54	35
2.5	.00	.16	.00	.13	.23	.23	.21	.29	.44	.24	.31	50	46	.46	.32
3.0	.00	.10	.00	.08	.14	18	.18	.25	.33	.24	.26	.41	.46	.42	.28

TABLE II.

Values of $\frac{V'-V_0}{V'}$ and μ_e for nitrogen

	$\frac{V'-V_0}{V'}$												$\mu_e \times 10^{-5}$ ($\theta = 90°$) (cm²/volt. sec.)		
	$\theta = 0°$			30°			60°			90°					
p-mm.Hg \ H in gauss	1750	2225	2500	1750	2225	2500	1750	2225	2500	1750	2225	2500	1750	2225	2500
0.4	.11	16	.15	.51	49	.47	.71	.76	.74	.75	.69	.79	.75	.56	.54
0.6	06	.06	.11	.44	.46	40	.66	.70	.64	.70	.66	.76	.72	.55	.53
0.8	.07	.07	.08	.38	.36	31	.63	.64	.54	.62	.56	.72	.68	.50	.52
1.0	.00	.05	.04	.33	.31	.11	.57	.60	.47	.54	.47	.62	.62	.46	.47
1.5	.00	.00	.07	.28	.29	.13	.50	.54	40	.47	.42	.52	.58	.43	.43
2.0	.00	.00	.00	.25	.27	.14	.42	.47	.34	.43	.34	.44	.55	.38	.39
2.5	.00	.00	.00	.19	.24	.08	39	.43	.26	.37	.27	.37	.51	.34	.36
3.0	.00	00	.00	.15	.18	.06	.34	.36	.23	.30	.28	.30	.45	.34	.32

TABLE III.

Values of $\frac{V'-V_0}{V'}$ and μ_e for carbon-dioxide

p-mm. Hg. \ H in gauss	$\frac{V'-V_0}{V'}$ $\theta = 0°$			30°			60°			90°			$\mu_e \times 10^{-5}$ ($\theta = 90°$) cm²/volt. sec.		
	2500	2950	3225	2500	2950	3225	2500	2950	3225	2500	2950	3225	2500	2950	3225
0 4	.08	.24	.28	72	.69	70	77	.80	79	79	80	82	54	.48	.43
0.6	00	16	.23	.64	60	.63	74	74	74	77	78	75	54	46	41
0.8	00	12	11	53	46	50	.71	72	.69	75	.72	73	53	.44	40
1.0	00	14	09	36	38	42	61	.62	62	62	70	66	.47	.43	.38
1.5	.00	.15	00	.22	23	32	.50	.53	55	57	.62	.58	45	40	.35
2.0	.00	.08	00	12	.16	23	.39	46	48	.37	55	50	.36	38	.33
2.5	.00	.05	00	04	09	.17	.31	.43	.41	.31	.47	44	.32	.34	.30
3.0	.00	.00	.00	.00	06	.05	20	.35	.32	.24	.40	.37	28	.31	.28

TABLE IV.

Values of $\frac{V'-V_0}{V'}$ and μ_e for hydrogen

p-mm. Hg. \ H in gauss	$\frac{V'-V_0}{V'}$ $\theta = 0°$ 2325	2550	3175	30° 2325	2550	3175	60° 2325	2550	3175	90° 2325	2550	3175	$\mu_e \times 10^{-5}$ ($\theta = 90°$) cm²/volt. sec. 2325	2550	3175
0.4	.25	.22	.20	.59	.62	66	.76	77	.79	.79	.78	.82	.59	.53	.44
0.6	.18	12	16	47	.46	.55	71	.71	73	.75	.74	.77	.57	.51	.42
0.8	.08	.07	17	.28	.36	46	.64	67	.68	67	.68	.74	53	.49	.41
1.0	.15	.03	.14	.17	.27	38	55	58	.63	.58	.60	.70	49	.45	.40
1.5	05	.00	.06	.09	.21	31	.47	52	55	51	.55	.67	.46	.43	.39
2.0	.09	00	05	.04	.16	21	39	43	.49	.48	.43	.55	.41	.40	.35
2.5	.00	.00	.00	.05	15	.20	.32	.35	.44	.41	.43	.51	40	.38	.33
3.0	.00	.00	.00	00	11	12	29	25	35	.36	.34	44	.38	.33	.31

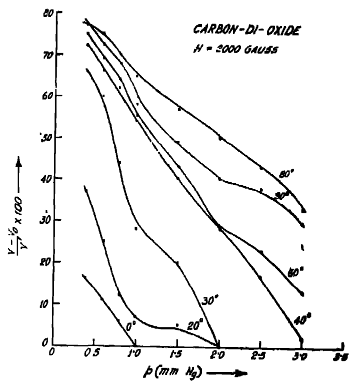

Fig. 5.

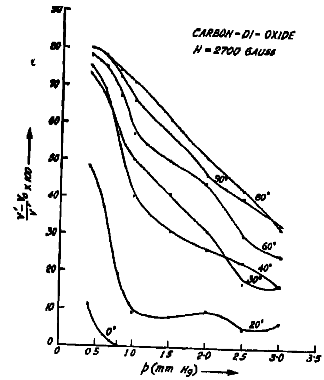

Fig. 6.

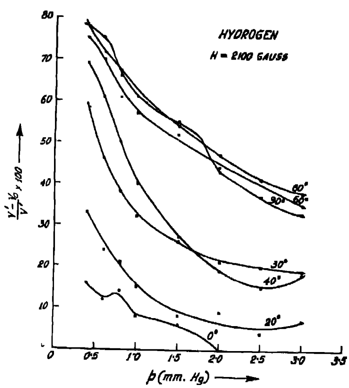

Fig. 7.

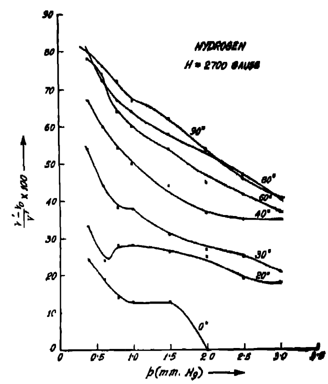

Fig. 8.

We have seen that
$$\phi = \frac{He\lambda}{m\bar{v}c} \qquad \dots \quad (1)$$

$$\mu_e = \frac{\cos^{-1}\left[1 - \dfrac{V' - V_0}{V'}\right]}{H} \times 10^8 \text{ cm}^2/\text{volt. sec} \qquad \dots \quad (2)$$

and
$$\frac{V' - V_0}{V'} = 1 - \cos\phi \qquad \dots \quad (3)$$

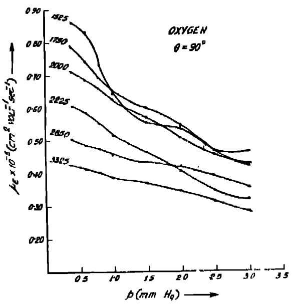

Fig. 9

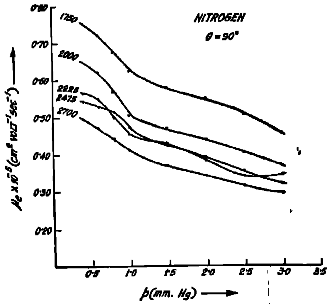

Fig 10

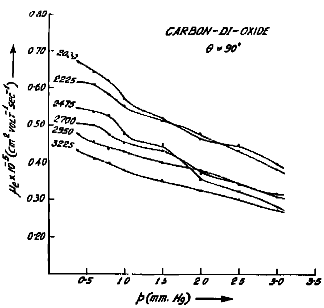

Fig. 11

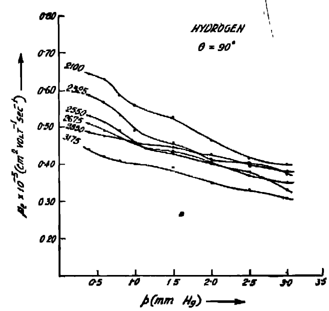

Fig. 12.

At constant temperature. $\lambda \propto \frac{1}{p}$, it follows from (1), (2) and (3) that under the present experimental conditions for a given H, both $p\phi$ and $p\mu_e$ are constant.

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